# Coastal Heritage

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## Citizen Science

*Encouraging Public Engagement*

# Contents



**ON THE COVER:**

*Folly Beach Turtle Watch volunteers probe a potential sea turtle nest site. The citizen scientists located buried eggs and marked the site for protection.*

PHOTO/GRACE BEAHM ALFORD




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*Coastal Science Serving South Carolina*

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**DATA DRIVEN.** *Folly Beach Turtle Watch leader Teresa Marshall, left, and Cindy Wynne note details about a nest found on one of their morning patrols.*
PHOTO/GRACE BEAHM ALFORD

# Citizen Science

## *Encouraging Public Engagement*

**by Joey Holleman**

Teresa Marshall's cell phone buzzes nonstop between 6 a.m. and 8 a.m. throughout the summer, and she views the screen with excited anticipation each time.

As the leader of the Folly Beach Turtle Watch Program, Marshall walks a section of Folly Island each Monday and Tuesday during the six-month nesting season looking for the tell-tale tracks left by sea turtles that have crawled across the sand to bury eggs. The other days, she waits at home for messages from the group's other 65 volunteers.

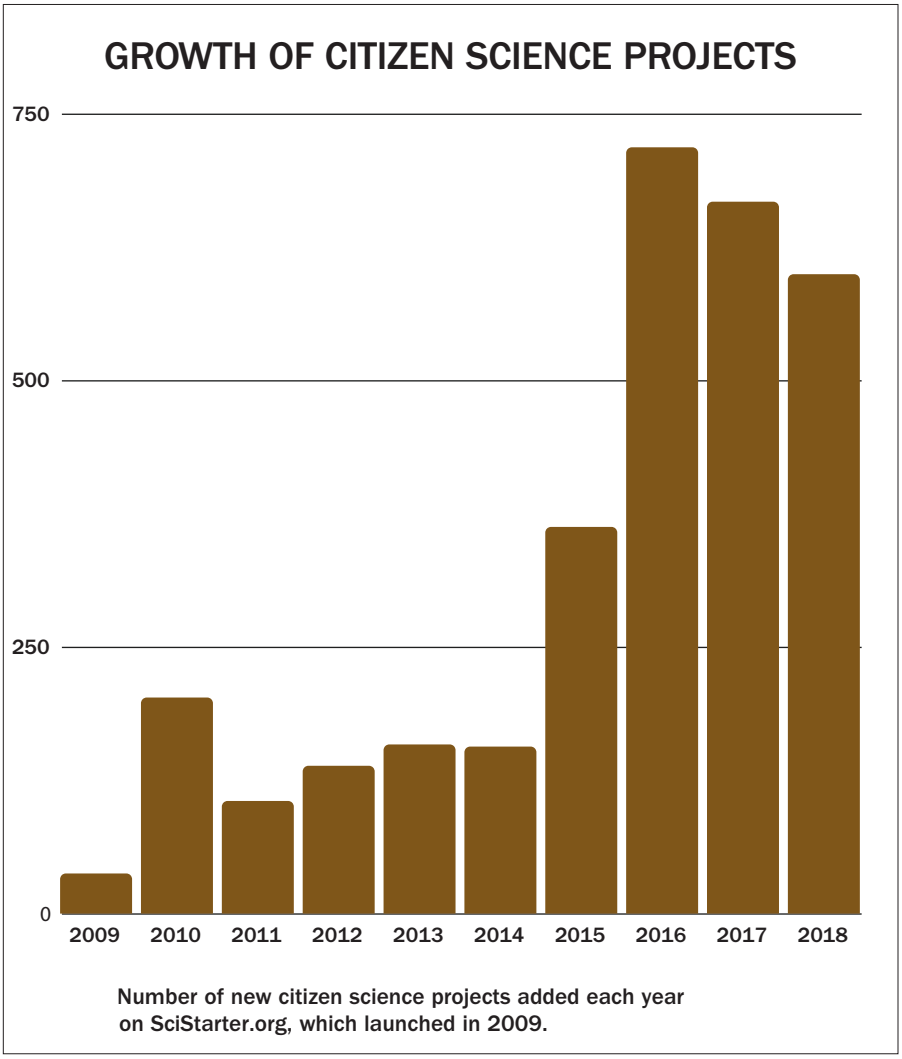
Most of the messages indicate no tracks found in each of the 11 sections of the beach covered by the volunteers, which makes the "I've got a crawl" messages even more exciting. Though some of the tracks end up being false crawls, when the turtle turns around before burying eggs in a nest, the patrols hit the jackpot early in the 2019 season. More nests were reported in the first month of this season than in all of the previous year.

Marshall has been doing this for six years, and her enthusiasm never wanes. "When you see those tracks it's just, 'Holy moly, this is awesome!' " Marshall says.

And that's the draw of citizen science, a broad term that applies to a range of ways the general public can contribute to research, data collection, or scientific engagement. One of the hallmarks is a true collaboration between scientists and volunteers. Often, citizen scientists get involved through a hobby or an environmental concern. For instance, amateur bird-watchers can participate by sharing lists of the species they spot in a specific area. Sometimes, people simply want to spend more time in the natural environment, and they do that by volunteering to test water quality in a nearby creek or pick up trash on a favorite beach.

The term "citizen science" first was recognized in the *Oxford English Dictionary* in 1989. However, the basic citizen science concept has been around much longer.

In the 1840s, the Smithsonian Institution rounded up 155 volunteers nationwide as Meteorological Correspondents. In 1885, William Whewell, a British philosopher and scientist,




**Number of new citizen science projects added each year on SciStarter.org, which launched in 2009.**

convinced 650 volunteers around the globe to participate in the Great Tide Experiment, providing tide reports at the same time and same point for two weeks. And in 1900, the National Audubon Society's Christmas Bird Count, one of the most famous citizen science projects, began as an alternative to traditional hunting trips around the holiday.

Because the modern hierarchy of secondary education and international organizations for trained scientists had yet to take hold by the early 1900s, nobody thought to call those participants citizen scientists. Instead, many were described as "gentlemen naturalists," according to Caren Cooper, an associate professor in the Forestry and Environmental Resources Department at North Carolina State University who chronicles trends in *Citizen Science: How Ordinary People are Changing the Face of Discovery*.

As scientific research became more formalized in the second half of the 20th century, academic credentials became critical for peer-reviewed research projects. But people without credentials still wanted to play a role in the scientific process. Cooper credits the publication of Rachel Carson's classic *Silent Spring* in 1962 and the passage of the Clean Water Act in 1972 for prompting environmental volunteers to spring into action as citizen scientists.

More than a century of Christmas Bird Count data now detail how hunting pressure, environmental manipulation, and changing climate affect the range and health of various species. Audubon's effort also set the standard for the explosion of citizen science that began in the 1990s when technology made sharing massive amounts of information much easier and quicker.

By 2019, more than 1,700 volunteer water-monitoring programs have popped up in the United States – including the Adopt-a-Stream program in South Carolina. The National Sea Grant College programs around the country in 2018 led or participated in 85 citizen science efforts – including Beach Sweep/River Sweep® and From Seeds to Shoreline® in South Carolina. The website SciStarter® connected volunteers with 600 new citizen science projects per year from 2016-2018. And the data collected in citizen science programs increasingly contribute to important research; the Cornell Lab of Ornithology's eBirds website, which expanded on the Christmas Bird Count concept, was cited in 45 peer-reviewed articles in 2018.

Cooper offers basic criteria for citizen science projects: follow a protocol created by scientists, collect data, and share observations. Furthermore, it works best if volunteers enjoy doing it, like the turtle volunteers walking beaches in the morning.

"Citizen science is often based on a division of labor: The field or lab work is fun, rewarding and/or relaxing enough to warrant dedicating leisure time, while nonleisurely activities, like statistical analyses, are carried out by paid scientists," Cooper writes.

Folly Beach Turtle Watch is part of the S.C. Marine Turtle Conservation Program begun by the S.C. Department of Natural Resources (SCDNR) in the early 1980s. The agency didn't have enough staff to collect information on nesting activity by endangered and threatened turtle species along the state's 187 miles of beaches, so it asked for help. What started as a handful of volunteers those first few years has grown into an army of more than 1,000 who locate, mark, and take steps to protect eggs during nesting season.

"Our volunteers were participants in coastwide sea turtle citizen science long before the term was brought into

our vernacular," says Michelle Pate, who directs the program for SCDNR. "Our volunteers dedicate their time, money, blood, sweat, and tears out of a desire to see good things occur in our state, and seek nothing in return."

In addition to their morning walks, the volunteers advocate for turtles, reminding people to fill holes and remove chairs and tents from beaches each night to make crawls across the sand easier for the hefty creatures, and to turn off lights that might lure hatchlings away from, rather than toward, the ocean. They also turn into educators when they interact with inquisitive early morning beach walkers.

Finally, they gather data on the number of false crawls when turtles don't deposit eggs, the number of nests, and the numbers of eggs or hatchlings in each nest. The data show the number of nesting female loggerheads has been on the upswing in South Carolina, and Pate credits the volunteer network as a critical step in that recovery.

SCDNR also relies on citizen science for its BatWatch program, diamondback terrapins sighting index, and Baltimore oriole winter survey. S.C. Department of Health and Environmental Control–Ocean and Coastal Resource Management (SCDHEC-OCRM) asks people to submit photos and details of flooding during King Tides in a citizen science effort known as MyCoast. The Southeast Coastal Ocean Observing Regional Association challenges people to review archived webcam footage from seven ocean piers to help count right whales, spot rip currents, and validate wave-height models.

## EARLY ADOPTERS STILL LEADERS

Audubon set the citizen science trend more than a century ago, and the early citizen science standard-bearer remains out front with its partners at Cornell Lab of Ornithology. Audubon researchers compiled a ground-breaking "Birds and Climate Change Report" in 2014, revealing shrinking and shifting of areas where birds have been spotted. It projects 314 of 588 bird species in North America will lose more than 50 percent of their range by 2080. That important work would have been impossible without the citizen scientists who contributed to Audubon's Christmas Bird Count and Great Backyard Bird Count and Cornell Lab's Project FeederWatch and eBird online checklist program.

After the climate report came out, volunteers wanted to know how they could help. Thus was born Climate Watch, a program designed to allow people to track changes in the range of various species that are easy to identify and expected to be severely impacted by climate change. In coastal South Carolina, dozens of Climate Watch volunteers hit the waterways, swamps, and forests each January 15-February 15 and May 15-June 15 searching for Eastern Bluebirds. Organizers provide map grids, and volunteers spend five minutes each at 12 selected sites on the grids, counting and reporting the number of bluebirds spotted.

Judith Kramer of Summerville has been participating in the local Climate Watch for three years. When rain interrupted a trip on June 10, 2019, she says she expected to see few birds. However, it seemed when the rain stopped, birds took advantage of the break to gather food. Slogging around in the rain stretched the typical two-hour trip to four hours, but she and her partners counted well over a dozen bluebirds.

Kramer sees the effort as her small part in a broad and important project. A Master Naturalist, she ascribes to the native tribe viewpoint of treating the natural environment with future generations in mind. "It's really important to me that I do something," she says. "I have two grandchildren whose children I would like to experience the natural world."

Audubon posts summaries online from each reporting period. The Climate Watch program is too new to allow conclusions, and the reasons for changes in species' ranges are complicated. That's why the work of the citizen scientists is so vital. "While we are already seeing important trends," the 2017 annual report states, "more data and greater participation will make these analyses much more concrete."

**SENTINEL SPECIES.** *The National Audubon Society's Climate Watch project involves citizen scientists looking out for Eastern Bluebirds in set locations each year to track changes in their range.*
PHOTO/U.S. FISH AND WILDLIFE SERVICE

## HARNESSING THE POWER OF CROWDS

The variety of citizen science projects available now is astounding. SciStarter, the website devoted to matching volunteers with citizen science, has more than 3,000 registered projects. Some are amazingly simple, like the Izaak Walton League's Stream Selfie, which asks participants to take a photo of themselves next to a stream, answer a few basic questions about the stream, and upload the answers and the photo. The goal is to map streams and encourage water monitoring.

That represents citizen science's crowdsourcing branch, which requires large numbers of people, often remotely over the internet, to divide up work. Crowdsourcing proved to be a godsend as technological breakthroughs in the past three decades created a data deluge. For instance, powerful telescopes and infrared imaging allowed hundreds of thousands of galaxies to be seen well enough to judge their shapes, and basic shape identification – spiral, elliptical, or irregular – reveals much about the makeup of a galaxy.

In 2007, Oxford University astrophysicists Kevin Schawinski and Chris Lintott faced the daunting task of identifying the shapes of about 900,000 galaxies in the Sloan Digital Sky Survey, so they reached out to the public. Astronomy buffs flocked to their Galaxy Zoo website, and more than 100,000 volunteers made 40 million shape identifications in 175 days. That became known as Galaxy Zoo 1, and 14 more major projects have followed. The Galaxy Zoo concept morphed into a crowdsourcing repository website, www.zooniverse.org.

While Galaxy Zoo deals with the way-out-there, the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) is as close as your yard. Its formation was prompted in 1997 by scattered thunderstorms that dumped 14.5 inches of rain in a few hours in a small geographic area near Fort Collins, Colorado. Official National Weather Service (NWS) gauges nearby recorded only a couple of inches of rain, and flood predictions were inaccurate. Five people died, and communities around Fort Collins suffered millions of dollars in damages.

In response, meteorologists in Colorado began recruiting volunteers to report daily rain totals from their yards. Including those data with the daily totals from official NWS gauge sites allows forecasters to predict river floods and widespread droughts.

CoCoRaHS slowly spread to other states, by 2008 reaching South Carolina, where data from backyard observers helped scientists better understand the October 2015 extreme rain event. Official NWS sites in the Charleston area indicated the six-day rainfall at 16-18 inches. But adding in the 24 CoCoRaHS sites that reported through the storm boosted the average to nearly 28 inches, according to the S.C. State Climate Office.

Assistant State Climatologist Melissa Griffin is such a fan of CoCoRaHS that she wore a raindrop costume to recruit volunteers at the 2019 Palmetto Sportsmen's Classic in Columbia. While an average of 360 CoCoRaHS reports are filed in the state each day, the lack of sites in several rural counties makes it more difficult for Griffin to evaluate conditions in those regions. Early in 2019, Darlington and Florence counties had three observers each, Marlboro and Chesterfield counties had two each, and Marion County had none.

That five-county region was ground-zero for flooding during Hurricane Matthew in 2016 and Hurricane Florence in 2018. Fortunately, several counties over the border in North Carolina have more observers, which improved river flood forecasts after the storms passed. But


**DAILY ROUTINE.** *Steven Taylor checks his backyard rain gauge every morning and enters the amount, even if it's zero, in the Community Collaborative Rain, Hail, and Snow network database.*
PHOTO/GRACE BEAHM ALFORD

MELISSA GRIFFIN

*"If there had been more observers during Florence, we would have had a better understanding of the breadth of the rain. There was such a quick die-off of rain just a few miles west."*

those forecasts could have been more informed with additional CoCoRaHS observers. "Having that ground truth is so important," Griffin says. "If there had been more observers during Florence, we would have had a better understanding of the breadth of the rain. There was such a quick die-off of rain just a few miles west."

Steven Taylor, a forecaster in the NWS Charleston office, is a CoCoRaHS observer. He says the effort for volunteers is minimal. Most days, he heads out around 8 a.m. and checks the gauge at his West Ashley home. During the October 2015 deluge, he rushed out several times a day to get a measurement and dump water from his gauge to keep it from overflowing.

Because of his profession, he feels a particular responsibility to provide accurate measurements. "The extra data help a tremendous amount," he says. "In 2015, we were getting a lot of reports, and that helped verify and calibrate radar-estimated totals."

CoCoRaHS volunteers pay $40 for a gauge and go through minimal training. While the system depends on daily reports, volunteers who head out of town also can provide multiday reports when they return. The data collected is archived and considered reliable enough for use in peer-reviewed scientific research.

**STREAM QUALITY.** *S.C. Adopt-a-Stream volunteer Malcolm Gordge performs monthly monitoring to determine the health of Hood Branch, a creek that runs through Camp Discovery in Richland County.*
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

"Precipitation is so variable," Griffin says. "The denser the network of gauges, the better the information you get."

## MORE TECHNICAL PROJECTS REQUIRE MORE TRAINING

Rain gauges and the data they produce are straightforward. Other citizen science projects enter more complicated realms, and skeptics raise doubts about the validity of the data produced. The best projects acknowledge that challenge, provide volunteer training, and recheck results when data seem well outside the norm.

For instance, the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science asks volunteers in the Phytoplankton Monitoring Network (PMN) to collect and analyze water samples to provide early warning of potentially harmful algal blooms in coastal waters. Training sessions last about 2.5 hours for marine waterways and 1.5 hours for freshwater locations. While the water collection takes only a few minutes, volunteers are expected to view samples under their microscopes, which takes from 20 minutes to more than an hour.

Because of the technical nature of identifying algae, regional coordinators are available to assist by email and phone. Also, when potential problem phytoplankton show up, the volunteers send photos and samples to coordinators for confirmation.

**HEALTHY HARBINGERS.** *Karen Jackson, a water resources extension agent with Clemson University, scans a net for macroinvertebrates, a S.C. Adopt-a-Stream protocol performed every three months.*
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

The PMN was established in 2001 during an early wave of citizen science projects. The S.C. Adopt-a-Stream program, started in 2017 by SCDHEC and Clemson University's Center for Watershed Excellence, represents the most recent expansion of the trend. Adopt-a-Stream volunteers must take a six-hour course and pass written and field tests. Checking waterways for acidity, water temperature, air temperature, dissolved oxygen, and conductivity qualifies as true science work.

In the Midlands of South Carolina, volunteer field training often is done at Camp Discovery in Blythewood. Camp Discovery board member Malcolm Gordge heard about Adopt-a-Stream and thought Hood Branch, which passes through the camp's property, would be an ideal monitoring site. When program officials checked out the stream, they decided the small waterway and adjacent open field made for an ideal training site.

For the past few years, this shallow 12-foot-wide tributary of the Wateree River has been monitored more than just about any similar waterway in the state. Karen Jackson, a water resources extension agent with Clemson, conducts training at the site and joins Gordge for his monthly monitoring sessions. At most sites, Clemson experts join volunteers only for the first few sessions.

Monitoring protocols are complicated. Two containers of water have to be filled from the middle of the creek. Testing for pH involves adding a reagent and gauging the color of the water against a standard. In a separate sample, monitors use droppers to carefully add manganous sulfate, sulfuric acid, sodium thiosulfate, and a starch indicator solution to determine dissolved oxygen content.

"I tell them during training, it'll seem like an eternity," Jackson says. "But once you do it every month and you get used to it, it'll go fast." She also tells them not to sample alone. It's not much fun by yourself, and you do a better job as a team.

Once they get the process down, most stream monitors can get in and out in 20 minutes. But every three months, the trip stretches closer to an hour because they check for macroinvertebrates, little creatures that teem in healthy waters.

One member of the team anchors a fine-mesh net in the streambed, and the other member disturbs the stream bottom just upstream allowing macroinvertebrates to flow into the net. (The Adopt-a-Stream protocols fit wadable streams, not rivers.)

After dumping the contents of the net into several shallow plastic containers, the monitors then pick out tiny aquatic insects like caddisflies, stoneflies, and mayflies. Each species is dropped into different sections of a plastic ice tray. The variety and quantity of species are tallied, and the numbers help rate the stream's water quality.

The water quality of Hood Branch generally is good, though one particularly high reading for fecal coliform helped alert an upstream property owner that a fence had been breached and livestock were wading in the water.

"We're not going out looking for problems," Jackson says. "It's more getting people out in the streams and learning about their water systems. Hopefully, people then go home and take a look at what they're doing on land that can affect water quality."

Despite the training required and the up-front cost for a kit, S.C. Adopt-a-Stream grew in a couple of years to 208 sites with 718 certified volunteers in 2018.

Gordge looks forward to his monthly trip to Hood Branch. "I absolutely enjoy the experience and the discovery," he says. "And I love the idea of taking better care of our water system, because so many people think it's just coming out of the pipes."

## PROJECTS ACCENTUATE SENSE OF PLACE

Stream monitoring represents place-based citizen science where volunteers get involved primarily because of their connection to a location. Place-based citizen science is a hallmark of the National Sea Grant College Program, which found that a local focus presents challenges (limited volunteer pool) and benefits (a true sense of stewardship for the volunteers).

S.C. Sea Grant Consortium's longest-running citizen science effort is Beach Sweep/River Sweep, which started in 1988. Pat Pierce volunteered that year at Huntington Beach State Park, and the haul of litter on the beach astounded her. "We found enough clothes that we could have dressed a man from head to toe," she says. "It was eye-opening to me."

She decided to serve as site captain for her own sweep closer to home in Myrtle Beach, and she has led a sweep every year since. "We have had as many as 65 people and as few as three" when the trio braved a steady rain that scared away everyone else, she says.

The volunteer crew typically includes scout groups, young students with their parents, and high school students. Some come back year after year. Pierce says one of her former elementary school students returned from college last year to help with the sweep.

Pierce currently is a blended learning coach in a virtual charter school, and she taught in traditional classrooms for more than 40 years, mostly in Horry County. When in the

**TRUE DEDICATION.** *Some Beach Sweep/River Sweep participants choose to clean beaches. Others, like these students, brave the pluff mud to remove trash at Charleston's Waterfront Park.*
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

standard school setting, she volunteered to handle the bulletin boards in August and September so she could spread the word about litter prevention and cleanups like Beach Sweep/River Sweep.

"I do it not just because it needs to be done, but I look at it as you must take care of where you live," she says. "To spend an entire morning on the beach with people who are kind, concerned, it does not get any better than this."

She appreciates adult volunteers, and she gets really excited when many children show up. Then she goes into full education mode, teaching about the dangers plastics pose to marine life or explaining why people need to stay away from shorebird nesting areas. "If you make children more aware, they will make a difference," she says.

Beach Sweep/River Sweep is a bit of a hybrid in the citizen science field. Some site captains put more emphasis on stewardship than on data collection. But each site turns in a tally of the various items found, and the data is entered into the Ocean Conservancy's International Coastal Cleanup database, where it can be used to track trends. Pierce has noticed fewer plastic bags and straws, as environmental groups have stressed the dangers they pose to sea creatures, but she remains frustrated by the number of cigarette butts found on the beach.

Pierce also participates in the From Seeds to Shoreline program, does Master Naturalist outreach, and has begun training for volunteer stream monitoring. In fact, she jumps at every chance she gets to learn and then to pass along knowledge. She did that even before citizen science became trendy.

## PUBLIC ENGAGEMENT DRIVES SOME PROJECTS

Like many citizen science projects, Beach Sweep/River Sweep borrowed from Audubon's early framework for success. The Christmas Bird Count revealed the importance of making volunteers feel as if they are contributing to a greater cause, doing it with people who have similar interests, and gaining knowledge in the process. A report by the National Academies of Sciences, Engineering, and Medicine in 2018 went so far as to say if a citizen science project doesn't involve learning, the scientists involved are just looking for free labor.

In some cases – SCDNR's 2019

**VETERAN VOLUNTEER.** *Larry Lane, a military retiree who joins several archaeology digs each year, has enough background knowledge to fit in with the professionals at the Pockoy Island shell ring excavation.*
PHOTO/GRACE BEAHM ALFORD

Pockoy Island archaeology dig and S.C. Sea Grant Consortium's From Seeds to Shoreline program are good examples – learning is the primary goal.

Archaeology digs require scraping thin layers of dirt with a shovel and detailing what is found at specific depths. Artifacts and changes in soil makeup at each layer tell a story of what happened during the period when that layer was on the surface, before it was covered by sedimentation. Archaeologists train for decades to interpret the past from data gathered in digs. Some of the work at a dig site, however, can be done with little or no background in the field. That, along with a natural fascination with the past, make archaeology a popular outlet for citizen science.

When SCDNR scheduled a month-long exploration of an ancient shell ring on Pockoy Island at the Botany Bay Heritage Preserve, the organizers decided to open five-hour work slots to volunteers. They posted an online schedule of 168 time periods during the month of May for volunteers to sign up, and every slot was filled within 48 hours, says Meg Gaillard, an archaeologist with SCDNR who coordinated logistics at the Pockoy Island dig.

The nature of archaeology digs creates two levels of citizen scientists – those with expertise and those with enthusiasm but little background knowledge. Larry Lane fits the first description. The Blythewood, S.C. resident earned an undergraduate degree in anthropology before his career arc led to public affairs work in the military. Now retired, he spends large chunks of each year volunteering at digs.

"It's kind of a hobby, in a sense, but it's nice that they keep asking me back," says Lane, while helping sift shovels full of dirt to look for artifacts. "I do have more experience than most of the volunteers, but I'm always learning."

Lane jokes that he's just a "shovel bum" who loves discovery, but graduate students working on the dig respect his experience. They ask his opinions about whether an artifact is animal bone or shell or whether changes in soil coloration hint to the location of a wooden post of an ancient structure.

**HISTORIC HAUL.** ***Archaeologists at the Pockoy Island shell ring excavation display interesting artifacts to help educate modern residents about the people who lived in the area over 4,000 years ago.***
PHOTO/GRACE BEAHM ALFORD

The Pockoy Island effort was spawned by ground-penetrating radar images that indicated two underground rings on the island. A pair of digs in 2018 on the area closest to the shoreline revealed a ring of shells, likely deposited in that formation during multiple ceremonial gatherings about 4,300 years ago. Exploration of such rings along the coast informs hypotheses on how those cultures lived.

Unfortunately, Pockoy Island's rings are among an estimated 19,000 archaeological sites projected to be under water with an expected three feet of sea-level rise in coming decades. An extreme tide infiltrated the site during the December 2018 dig, and another would have done the same if not for a small berm pushed up by the dig staff in May 2019.

The dig might be the last chance to explore the ring before the ocean inundates it, so this was an all-hands-on-deck effort. And those hands included volunteers with no expertise in the field, like Kimberly McCoy of Bluffton, S.C.

"It popped up in my local newspaper, and I thought this was the coolest thing," McCoy says while sorting through debris on a sifting tray. "I had no idea things like this happened. It seemed like a chance to learn something new."

Working alongside SCDNR archaeology intern Cate Garcia, McCoy spends a morning cleaning sticky dirt off clumps of debris scraped from the heart of a shell ring. A clump might turn out to be another oyster shell, a human-manipulated stone tool, or an ancient crab claw.

"Everything I find is cool to me!" McCoy says. Her shift is scheduled to last five hours, but she jokes that "it's going to be 9 p.m. and they're going to have to say 'We're going to need you to go home now.' "

Experienced volunteers like Lane expand the data-gathering potential of a dig. Inexperienced volunteers like McCoy represent citizen science as an educational outreach tool. Another

example of the branch of citizen science stressing outreach is From Seeds to Shoreline.

Started in 2011 by the S.C. Sea Grant Consortium, SCDNR, and Clemson University Extension, From Seeds to Shoreline involves K-12 students in the science of marsh restoration. They gather seeds in the fall from *Sporobolus alterniflorus*, the smooth cordgrass that dominates saltwater marshes in the Southeast. (The scientific name recently was changed, and many still refer to the grass by its former name, *Spartina*.)

Students and teachers propagate seedlings in greenhouses at their schools through the winter. Late in the school year, they travel to marshes and plant seedlings in bare areas that need more roots to hold onto the mud during high tides.

The data gathered is minimal, mostly details on the number of seedlings planted and the linear feet of marshes restored. As for the other hallmarks of citizen science, From Seeds to Shoreline follows set protocols, and it practically overflows with shared observations on the personal level.

"What is marsh grass good for?" Consortium Marine Education Specialist E.V. Bell asks a group of students from Edisto Island's Jane Edwards Elementary School during a May 2019 marsh planting trip.

"It's good for the mud!" one of the children responds.

"Are we going to be playing in the mud?" Bell asks.

"No!" the children respond.

"No, we're going to be planting in the mud!" Bell says.

And for the next 20 minutes, the children use trowels to dig holes, drop their seedlings into the holes, then pat mud back on top of the seedlings' roots. Invariably, they head home with pluff mud on their shoes, or their clothes, or their faces. But they also come away with knowledge that the marsh grass so prevalent in their landscape comes from seeds, thrives in mud, and is critical for the other creatures that live in marshes – and that they, as tiny citizen scientists, contributed to maintaining a healthy marsh.

**HELPING NATURE.** *The From Seeds to Shoreline program involves students in collecting and propagating cordgrass seeds, then transplanting seedlings near the end of the school year to restore salt marsh.*
PHOTO/GRACE BEAHM ALFORD

## CITIZEN SCIENCE'S IMPORTANCE GROWING

As it percolated for the past century and a half, citizen science evolved slowly, mostly through large projects like the Christmas Bird Count. In the past three decades, however, citizen science exploded into an important scientific force.

A 2015 study reported in the journal *Biological Conservation* found that nearly 1.3 million citizen science volunteers contribute up to $2.5 billion of in-kind labor annually.

In 2016, Congress recognized the trend by passing legislation that encouraged and set guidelines for citizen science coordinated by federal agencies.

In March 2019, more than 800 proponents from 28 countries gathered at CitSci2019, the annual conference of the Citizen Science Association, in Raleigh, N.C. Rachael Polmanteer, a middle school teacher in Raleigh, spoke at the conference about how she integrated citizen science into her classroom. Her students participate in North Carolina's Candid Critters, which identifies wildlife images captured on camera traps, and Ant Picnic, that tracks which foods attract the most ants.

"It's amazing to watch eighth-graders who usually only care about their cell phones develop enthusiasm for science," Polmanteer says.

Like so many at the conference, Polmanteer says she can't wait to see where citizen science will take the younger generation, and where those youngsters might steer citizen science. The Cornell Lab's BirdSleuth program invites K-12 students to collect and report data on bird behavior. It encourages tweaking of protocols, resulting in elementary school projects that test whether store-bought or homemade suet attracts more birds to feeders, whether playing classical

music near a feeder lures more birds, and whether a stuffed squirrel or a photograph of a cat placed near a feeder will deter birds.

Some of those youngsters will become scientists. Others simply will appreciate the process of science, and maybe as adults participate in citizen science projects. Either way, they can have an impact.

In her book, Caren Cooper of North Carolina State University extols citizen science's ability to work over long time periods, across large or small geographical areas, and pull in millions of minds and eyes. Used correctly, she suggests, it can have an influence on science that rivals the role of computers.

"Observing and sharing our observations will become what it means to be a responsible human residing on planet earth," Cooper writes. "Citizen science is a passport to the rights and responsibilities of engaging in validated systems of discovery."

**FUTURE SCIENTISTS.** *Youngsters who participate in From Seeds to Shoreline represent a generation that can discover the full power of citizen science to change research.*
PHOTO/GRACE BEAHM ALFORD

## Reading and Websites

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**www.audubon.org/conservation/science/christmas-bird-count**

National Centers for Coastal Ocean Science Phytoplankton Monitoring Network.
**coastalscience.noaa.gov/research/stressor-impacts-mitigation/pmn/**

SciStarter.
**www.scistarter.org**

S.C. Adopt-a-Stream.
**scaas.app.clemson.edu/home.php**

S.C. Department of Health and Environmental Control MyCoast.
**www.mycoast.org/sc**

S.C. Department of Natural Resources Citizen Science.
**www.dnr.sc.gov/volunteering/index.html**

S.C. Department of Natural Resources Marine Turtle Conservation Program.
**www.dnr.sc.gov/seaturtle/volunteers.html**

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# NEWS & NOTES

## Consortium research benefits the state

Funding awarded by the National Sea Grant College Program to S.C. Sea Grant Consortium supported eight peer-reviewed research projects in fiscal years 2016-18. Results of four of those projects were presented in the Spring 2019 issue of *Coastal Heritage*. Following are brief summaries of the other four projects' results. More details are posted on the Consortium's website at www.scseagrant.org/past-research-2016-2018.

### SUSTAINABLE FISHERIES AND AQUACULTURE

- *Determining genetic diversity in overfished and recovered black seabass.* Tanya Darden and Tim O'Donnell, S.C. Department of Natural Resources.

S.C. Department of Natural Resources (SCDNR) researchers for decades have collected small inner-ear bones called otoliths from various fish species. With breakthroughs in genetic testing, those otoliths are a rich archive for research on the health of a variety of species.

The exploitation of reef fishes off the southeastern United States by commercial and recreational anglers has increased dramatically since the early 1970s, and many populations have been depleted as a result. Studies on a variety of marine fish species have indicated a reduction in population size diminishes genetic diversity, resulting in serious negative impacts on a stock's long-term sustainability and resilience to overfishing.

SCDNR researchers Tanya Darden and Tim O'Donnell examined the otoliths of black seabass, a species which has undergone substantial decline and rebound in recent years. DNA samples were used to quantify the genetic diversity of the stock through the years. A total of 659 black seabass were genotyped from 1981 to 2014.

Genetic diversity remained stable over the time period despite large fluctuations in the abundance of the species off the coast of the southeastern United States. It appears that black seabass in the South Atlantic Bight have not experienced a genetic bottleneck despite an estimated reduction of about 50 percent in biomass between 1980 and 1992 before a population recovery began in the late 2000s.

- *Determining optimal combinations of stock enhancement and harvest reduction for population restoration of inshore cobia.* Tanya Darden and Michael Denson, S.C. Department of Natural Resources.

The project used computer simulations of genetic data to forecast population abundance and genetic diversity for the inshore cobia population under several stock enhancement strategies and fishery management options. The resulting model provides resource managers with an objective, transparent, and defensible decision-making tool to choose the best combination of management choices for the inshore cobia population.

The optimal restoration strategy includes a combination of more restrictive fishing regulations and stock enhancement, as together these management actions have a greater potential for rapid success than either does alone. The tool shows how different levels of each action work in tandem to affect potential population abundance. The developed model can be applied to other species which have species-specific life history and genetic information available.

### HAZARD RESILIENCE IN COASTAL COMMUNITIES

- *How do low-impact development (LID) technologies respond to intense rainfall events?* Nigel Kaye and Will Martin, Clemson University.

A series of experiments were run to establish the hydraulic behavior of modular green roof systems. The goal was to improve the design of these systems to make them more effective at reducing peak discharge from a roof. Tests showed modular green roof systems as most commonly designed fail to detain significant amounts of rainfall for long periods of time. Researchers tweaked existing green roof modules by raising them and putting empty storage modules underneath. Testing of this design tweak found the peak runoff discharge was reduced by 88 percent compared to a standard impervious roof.

A second component was to assess the impact of LID technologies on an individual land development scale to determine reduction in peak discharge and total runoff when a traditional stormwater design is enhanced with the addition of modular green roof systems and porous pavements. The data indicated the use of the newly designed green roof system reduced the peak discharge but provided no significant reduction in total site discharge. Porous pavement systems did not make a major difference to the peak site discharge but did reduce total site runoff.

A third component focused on the potential benefits of land developers using LID technologies, thus indicating whether there are benefits

# NEWS & NOTES

of municipalities requiring LID technologies in their stormwater regulations. The study found LID technologies could allow a municipal storm sewer system to handle a 20 percent increase in design rainfall without exceeding the current peak discharge, and a 10 percent increase in design rainfall without exceeding the current total discharge.

- *Creating an adaptability toolkit for South Carolina's coastal water infrastructure.* Kalyan Piratla and Ashok Mishra, Clemson University.

The research focused on how planners can adapt to increased flooding and salt-water intrusion caused by sea-level rise and more intense rainfall associated with climate change. The team measured the increase in streamflow caused by land use and climate change using the Personal Computer Storm Water Management Model, which was calibrated and validated for the region so it can be used by urban planners.

The study also measured the extent of stormwater reduction after a watershed-scale implementation of two main low-impact development practices – rain gardens and rain barrels. In the baseline case, the runoff decreased by 10 percent when using rain barrels only, by 21.3 percent when using rain gardens only, and by 34 percent when using both.

The study also determined that the cost of reusing greywater – the residential wastewater stream not coming from toilets, and thus not containing fecal contamination – is higher than the benefits for now.

The researchers surveyed water infrastructure professionals from coastal communities throughout the United States to determine what adaptation strategies have been effective.

The report recommends incentivizing green infrastructure, upsizing drainage infrastructure, diversifying water sources, collecting infrastructure data for accurate model development, and developing educational programs to increase resident awareness of drainage infrastructure.

## Patrick McMillan wins S.C. Environmental Awareness Award

When Clemson University's Patrick McMillan accepted the 2018 S.C. Environmental Awareness Award, he praised the natural wonders of South Carolina and beseeched residents, especially newcomers, to appreciate what they have.

"I can't stress enough how important it is to keep South Carolina South Carolina," McMillan said at the award ceremony on May 28 at Harbison State Forest. "It's imperative to really instill upon people how important our choices are, how long-lasting those choices are, and how our decisions in our own backyards really determine whether or not South Carolina continues to be this vibrant, biodiverse crucible of life."

**Clemson University's Patrick McMillan is the 2018 S.C. Environmental Awareness Award winner.**
PHOTO/JOEY HOLLEMAN/S.C. SEA GRANT CONSORTIUM

Those choices can be as broad as conservation of large tracts of property or countywide land-use regulations, or as small as what people plant in their backyards, said McMillan, who is the Glenn and Heather Hilliard Professor of Environmental Sustainability in the Department of Forestry and Environmental Conservation at Clemson University, as well as director of the South Carolina Botanical Garden and the Clemson Experimental Forest.

McMillan's nomination for the annual award spotlighted his outreach through public speaking, guided botanical hikes, and the Emmy Award-winning SCETV program "Expeditions with Patrick McMillan."

McMillan received his B.S. in Biology from the University of North Carolina, Chapel Hill, and his Ph.D. in Biological Sciences from Clemson University. His career included stints as an environmental consultant and field ecologist, as well as an eighth-grade math and science teacher. He joined the faculty at Clemson in 2000.

The South Carolina General Assembly established the S.C. Environmental Awareness Award during the 1992 legislative session to recognize outstanding contributions to the protection, conservation, and improvement of the state's natural resources. Members of the award selection committee represent the S.C. Sea Grant Consortium, S.C. Forestry Commission, S.C. Department of Natural Resources, and S.C. Department of Health and Environmental Control.

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# EBBS & FLOWS

## 31st Annual Beach Sweep/River Sweep

*Statewide, South Carolina*
*September 21, 2019*

Join S.C. Sea Grant Consortium and S.C. Department of Natural Resources for the Beach Sweep/River Sweep litter cleanup. Volunteers remove debris and collect data to help track trash trends. To volunteer on the coast, contact Susan Ferris Hill at susan.ferris.hill@scseagrant.org. To volunteer inland, contact Bill Marshall at marshallb@dnr.sc.gov.

## National Coastal Conference

*Myrtle Beach, South Carolina*
*October 22-25, 2019*

The American Shore and Beach Preservation Association brings together engineers, scientists, planners, and students to talk about healthy, sustainable, and resilient coastal systems. Sessions will focus on flooding, community protection, ecological health, economics, and policy. For more information, visit www.asbpa.org/conferences.

## Stormwater Pond Management Conference

*Beaufort, South Carolina*
*November 13, 2019*

This conference is designed as a forum for stormwater pond owners, homeowners associations, property managers, and pond management professionals to learn about the latest science and management resources. Visit www.clemson.edu/extension/carolinaclear for more information.

**Subscriptions are free upon request by contacting: Joey.Holleman@scseagrant.org**

**ATTENTION SCHOOL TEACHERS!** The S.C. Sea Grant Consortium has designed supplemental classroom resources for this and past issues of *Coastal Heritage* magazine. *Coastal Heritage Curriculum Connection*, written for K-12 educators and their students, is aligned with the South Carolina state standards for the appropriate grade levels. Includes standards-based inquiry questions to lead students through explorations of the topic discussed. *Curriculum Connection* is available online at www.scseagrant.org/coastal–heritage–curriculum–connection.

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